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(54) TWO PIECE MANIFOLD

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(51) **Int. Cl.**

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F28F 9/18	(2006.01)
F28D 9/00	(2006.01)

(52) **U.S. Cl.**

CPC ***F28F 9/02*** (2013.01); ***F28D 1/05391*** (2013.01); ***F28D 9/0093*** (2013.01); ***F28F 9/0204*** (2013.01); ***F28F 9/0221*** (2013.01); ***F28F 9/0224*** (2013.01); ***F28F 9/182*** (2013.01)

(58) **Field of Classification Search**

CPC F28D 1/05391; F28F 9/0202; F28F 9/0221

USPC 165/174, 175, 176

See application file for complete search history.

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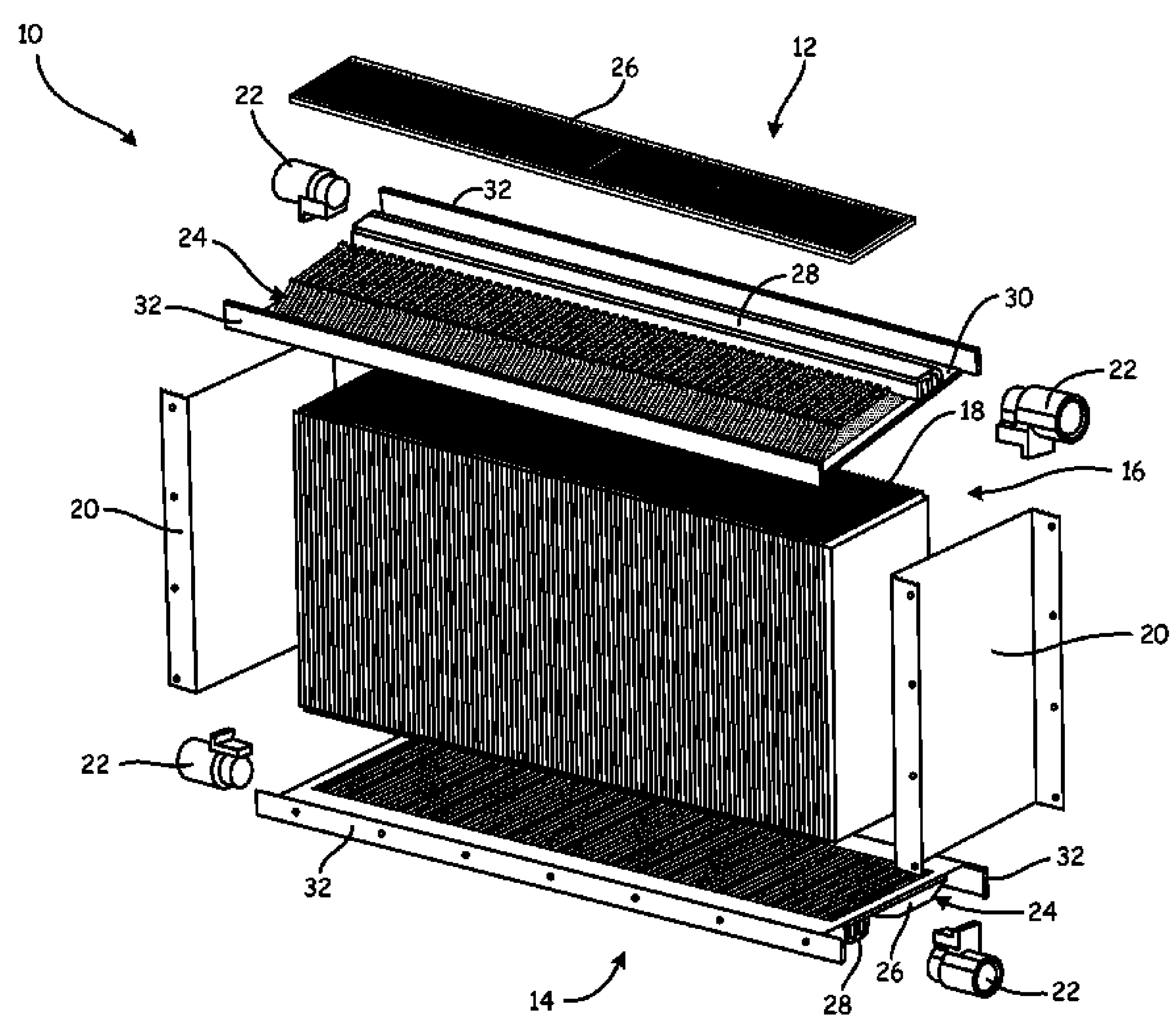
(57) ABSTRACT

A manifold for a heat exchanger assembly includes a body with a first end disposed opposite a second end, and a top surface disposed opposite a bottom surface. A first side surface extends between the top and bottom surfaces, and a second side surface extends between the top and bottom surfaces opposite the first side surface. A first plurality of chambers is formed in the body with each chamber of the first plurality of chambers being spaced apart from one another between the first end and the second end of the body. A second plurality of chambers is formed in the body with each chamber of the second plurality of chambers being spaced apart from one another between the first end and the second end of the body.

14 Claims, 5 Drawing Sheets



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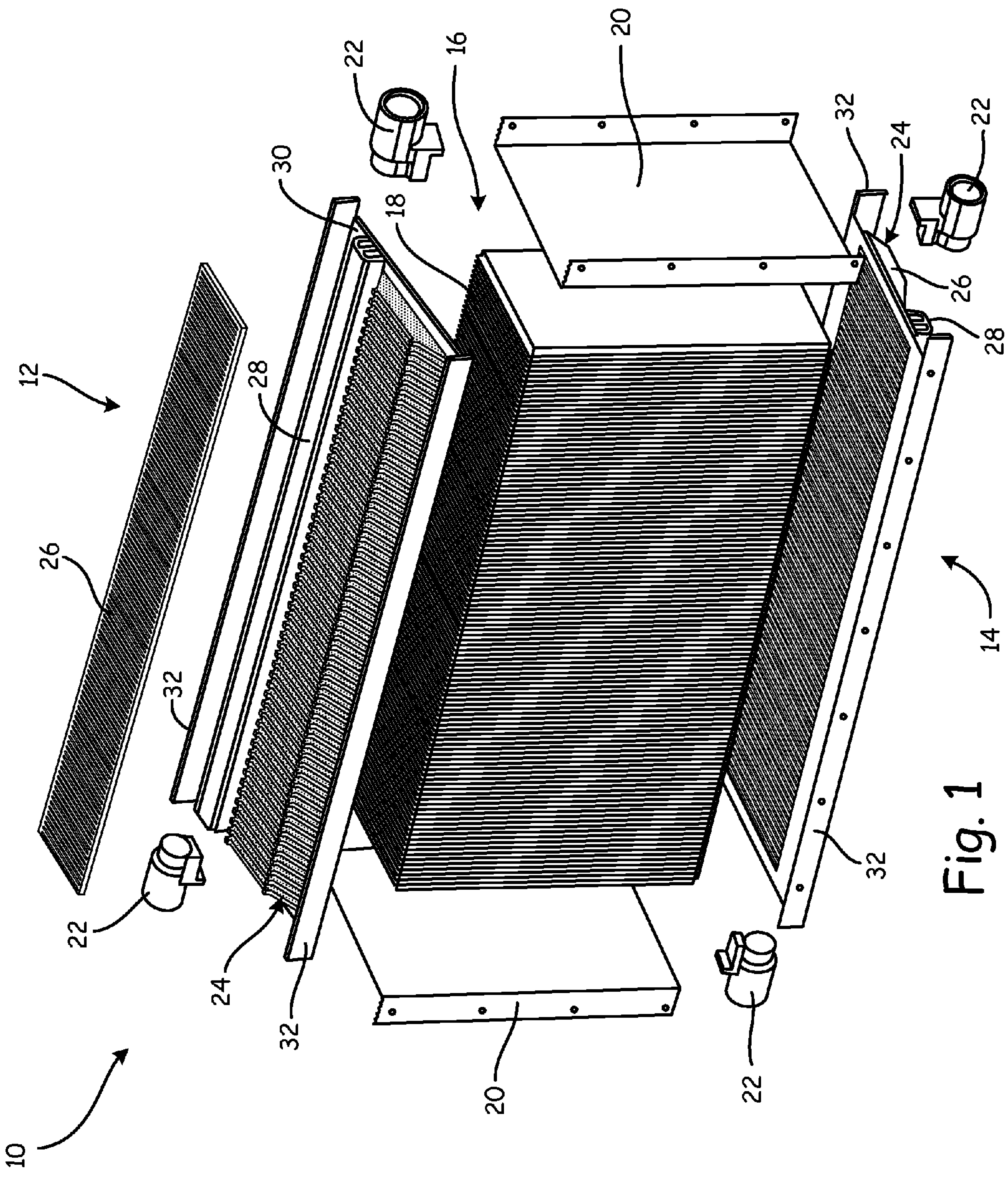

Fig. 1

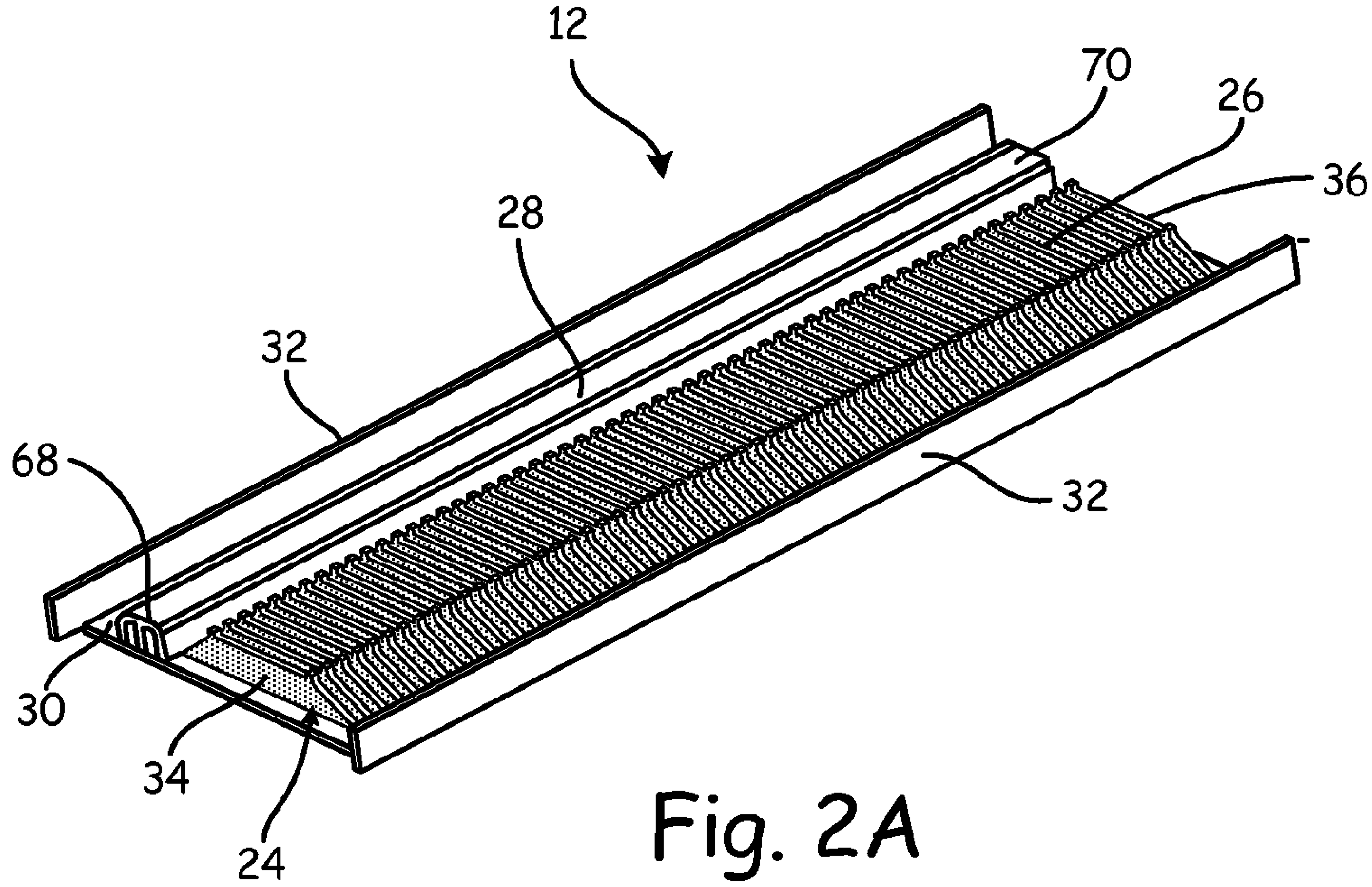
12
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Fig. 2A

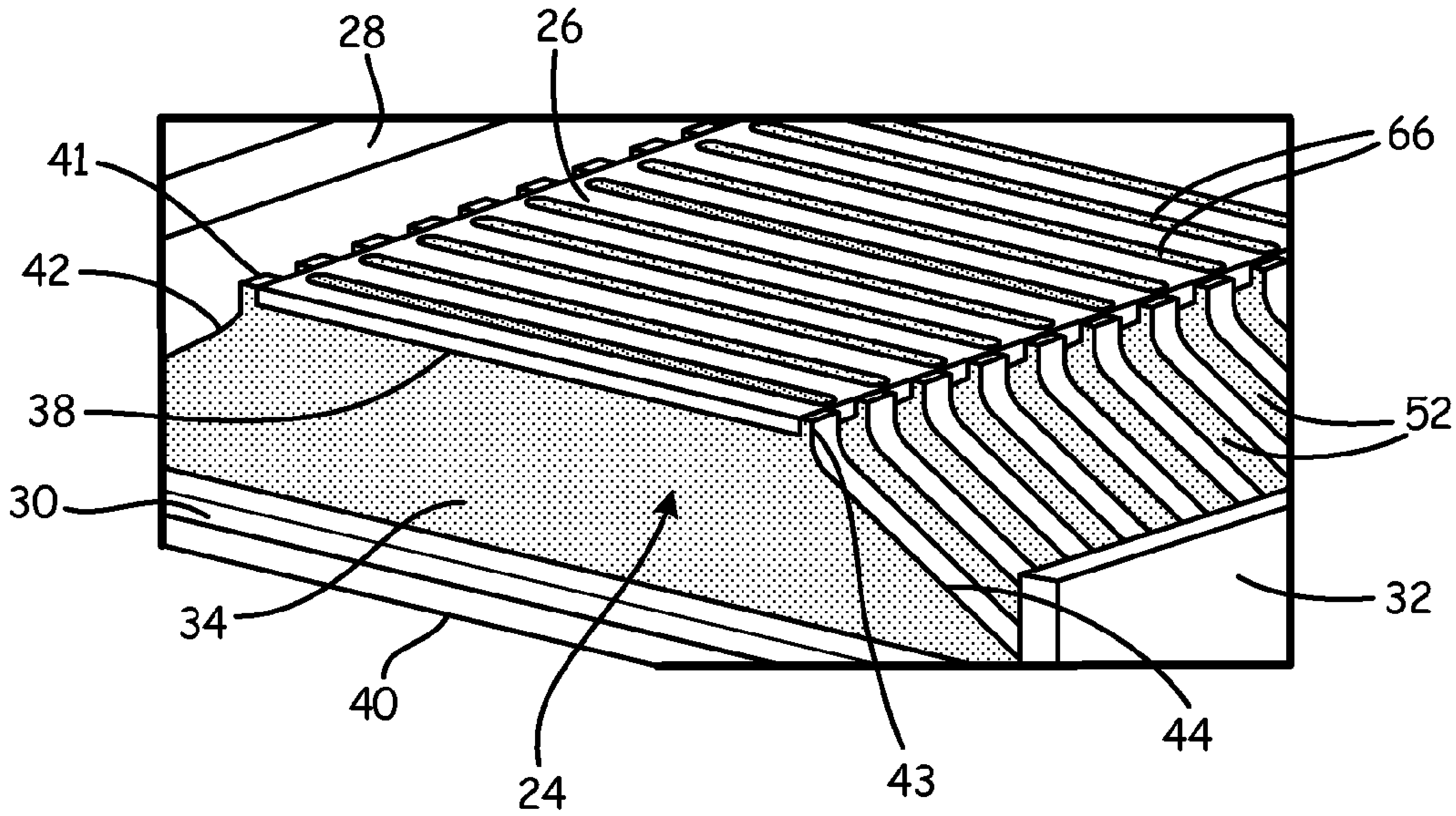
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Fig. 2B

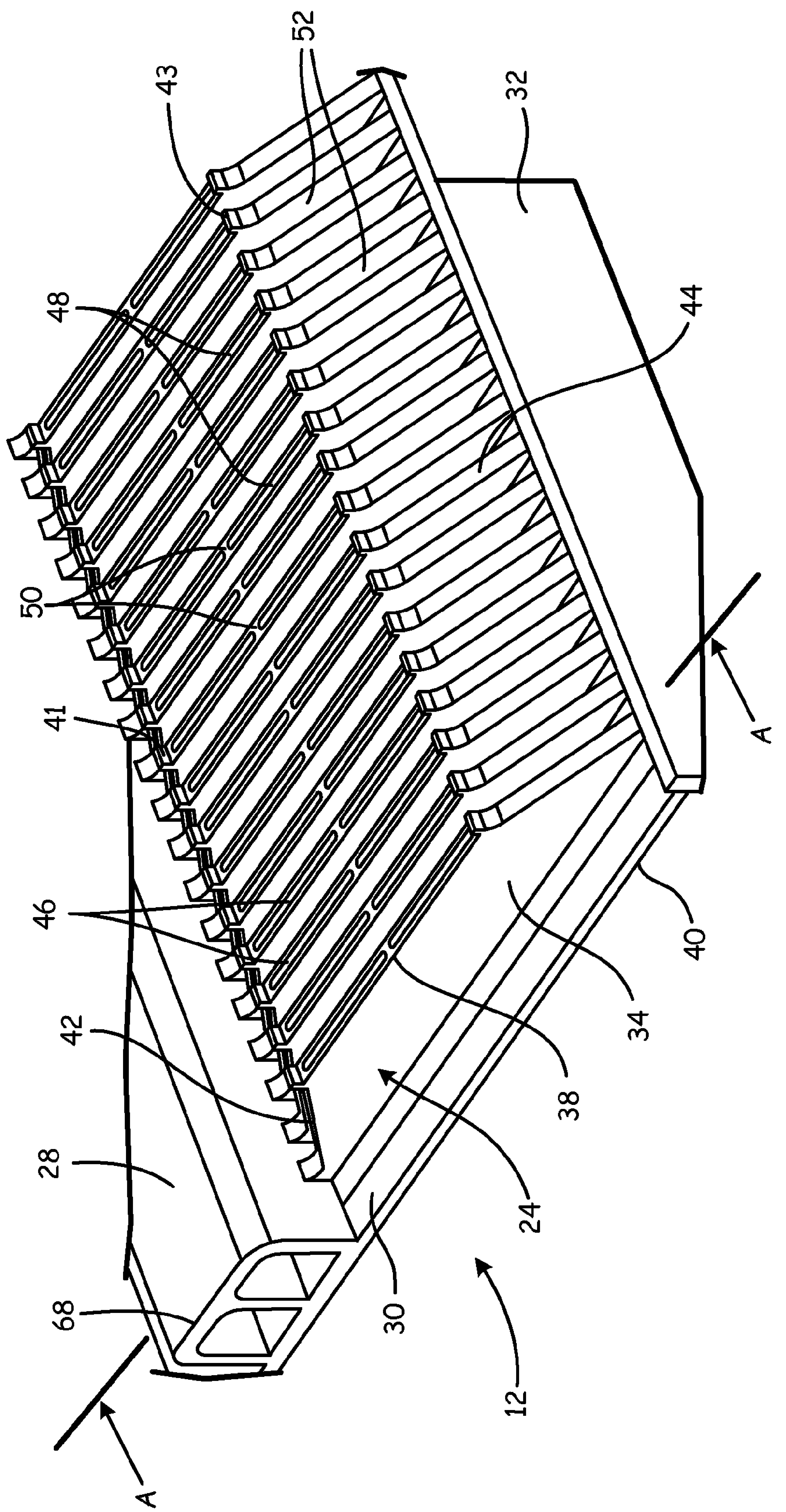

Fig. 3

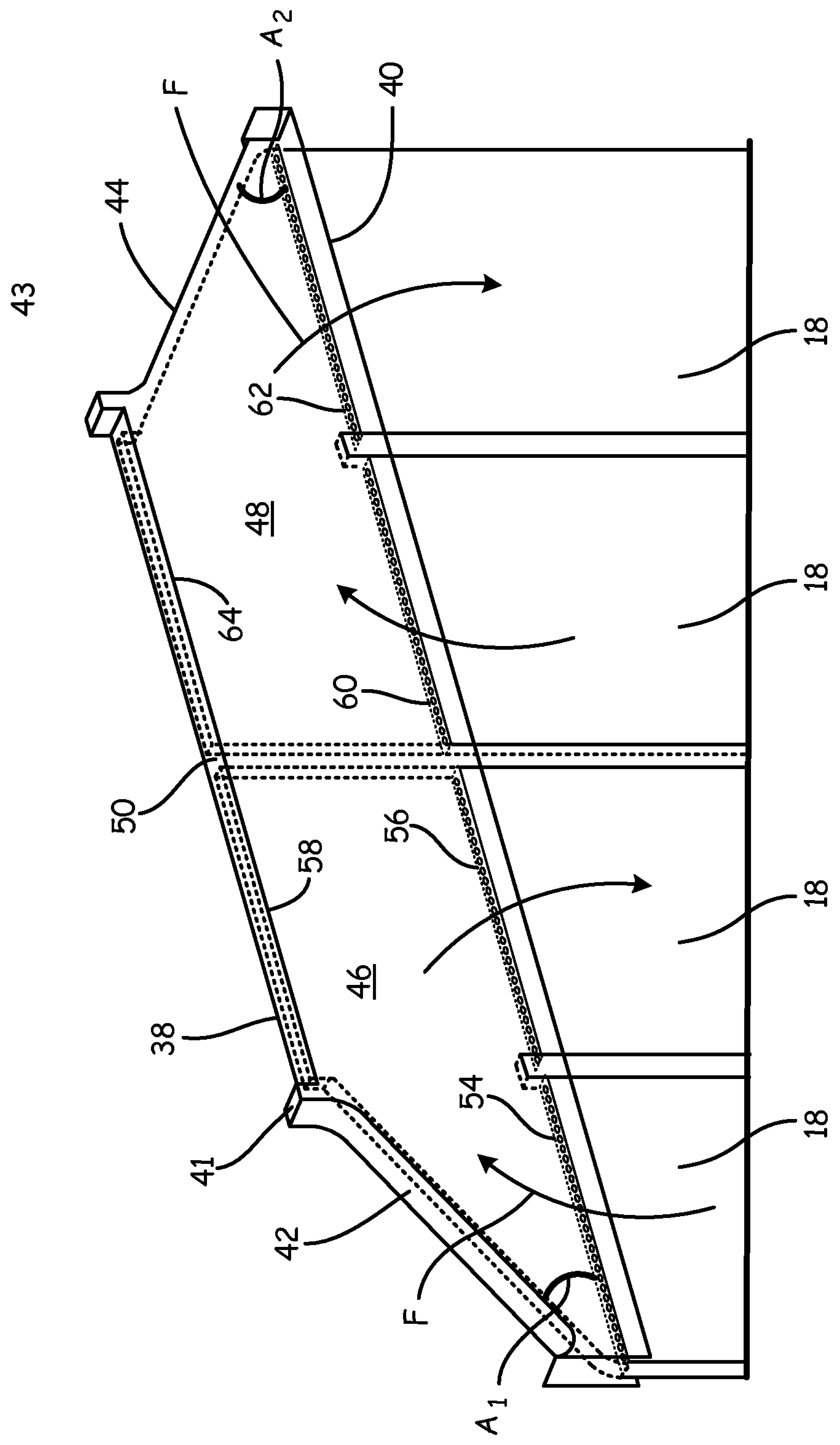

Fig. 4

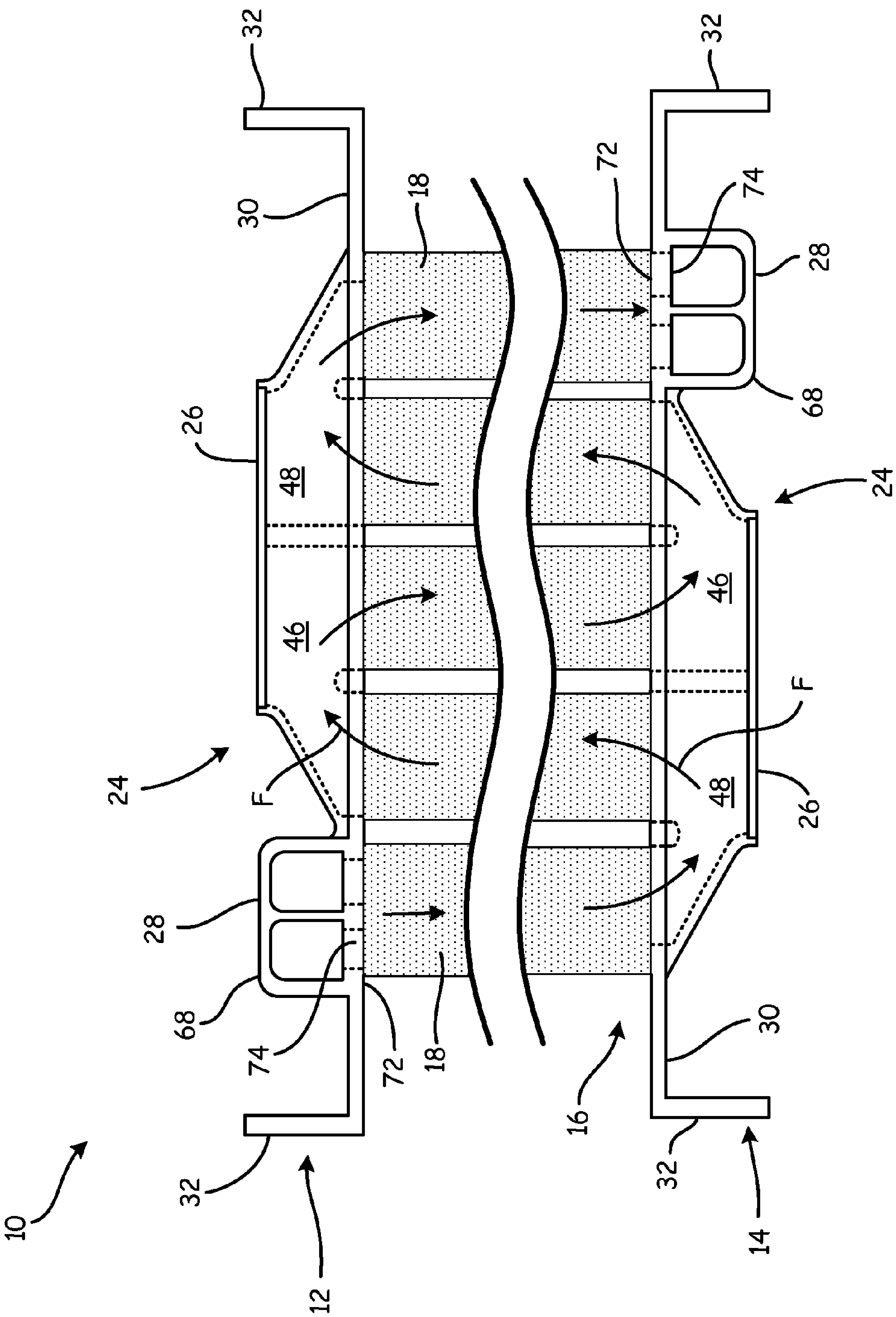

Fig. 5

TWO PIECE MANIFOLD

BACKGROUND

This disclosure relates generally to heat exchangers, and more particularly, to manifolds and headers for a mini- or micro-channel heat exchanger assembly.

Manifolds and headers used in multi-row mini- or micro-channel heat exchangers impart multiple manufacturing challenges. Mini-channel heat exchangers require manifolds or headers that are strong enough to withstand the elevated pressures exerted by fluids flowing through the manifolds or headers during operation. Typically, the headers are made from roll-formed, welded or hydroformed sheet metal. The manifolds are generally formed by extrusion or casting followed by subsequent machining. Generally, when manufacturing a manifold or header, multiple plugs must be brazed to the header to close any undesired openings in the header. Each brazing step required to manufacture the manifold or header significantly increases the labor cost to manufacture the manifold or header.

SUMMARY

In one aspect of the invention, a manifold for a heat exchanger assembly includes a body and a plate. The body includes a first end disposed opposite a second end, and a top surface disposed opposite a bottom surface. The body also includes a first side surface extending between the top surface and the bottom surface, and a second side surface extending between the top surface and the bottom surface opposite the first side surface. A first plurality of chambers are formed in the body such that each chamber of the first plurality of chambers extends from the top surface to the bottom surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface. Each chamber of the first plurality of chambers is also spaced apart from one another between the first end and the second end of the body. A second plurality of chambers is also formed in the body. Each chamber of the second plurality of chambers extends from the top surface to the bottom surface and extends between the second side surface and the intermediate plane. Each chamber of the second plurality of chambers is also spaced apart from one another between the first end and the second end of the body. The plate is disposed on the top surface of the body.

In another aspect of the invention, a manifold for a heat exchanger assembly includes a body having a first end disposed opposite a second end and a top surface disposed opposite a bottom surface. The body further includes a first side surface extending between the top surface and the bottom surface and a second side surface extending between the top surface and the bottom surface opposite the first side surface. A first plurality of chambers is formed in the body such that each chamber of the first plurality of chambers extends from the bottom surface towards the top surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface. Each chamber of the first plurality of chambers is also spaced apart from one another between the first end and the second end of the body. A second plurality of chambers is also formed in the body. Each chamber of the second plurality of chambers extends from the bottom surface towards the top surface and extends between the second side surface and the intermediate plane. Each chamber of the second plurality of chambers is also spaced apart from one another between the first end and the second end of the body.

Persons of ordinary skill in the art will recognize that other aspects and embodiments of the present invention are possible in view of the entirety of the present disclosure, including the accompanying figures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective exploded view of a heat exchanger assembly.

FIG. **2**A is a perspective view of a manifold from the heat exchanger assembly of FIG. **1**.

FIG. **2**B is an enlarged perspective view of the manifold from FIG. **2**A.

FIG. **3** is an enlarged perspective view of the manifold from FIG. **2**A with a plate removed.

FIG. **4** is a cross-sectional view of the manifold of FIG. **3** taken along line A-A and a plurality of heat exchanger tubes connected to the manifold.

FIG. **5** is an end elevation view of the heat exchanger assembly from FIG. **1**.

While the above-identified drawing figures set forth one or more embodiments of the invention, other embodiments are also contemplated. In all cases, this disclosure presents the invention by way of representation and not limitation. It should be understood that numerous other modifications and embodiments can be devised by those skilled in the art, which fall within the scope and spirit of the principles of the invention. The figures may not be drawn to scale, and applications and embodiments of the present invention may include features and components not specifically shown in the drawings. Like reference numerals identify similar structural elements.

DETAILED DESCRIPTION

The present disclosure provides a two-piece manifold for a mini-channel heat exchanger. The manifold includes at least two rows of chambers, with each chamber connected to no more than two mini-channel tubes. Because the manifold only includes two pieces, the manifold only requires one brazing step during manufacturing, thereby requiring a lower manufacturing cost in comparison to prior art heat exchanger manifolds and headers. As described below with reference to the Figures, heat exchanger assemblies that incorporate the present manifold are also relatively lighter than heat exchangers that incorporate prior art manifolds or headers because the present manifold requires significantly less fluid volume during operation than prior art manifolds and headers due to the chambers of the present manifold being connected to no more than two mini-channel tubes.

FIG. **1** is a perspective exploded view of heat exchanger assembly **10**. As shown in FIG. **1**, heat exchanger assembly **10** can include first manifold **12**, second manifold **14**, heat exchanger core **16** having a plurality of mini-channel tubes **18**, two end panels **20**, and fittings **22**. Each of manifolds **12** and **14** can include body **24**, plate **26**, fluid channel **28**, base plate **30**, and side flanges **32**.

First manifold **12** is disposed opposite second manifold **14** such that a bottom surface of manifold **12** faces a bottom surface of second manifold **14**. Heat exchanger core **16** is disposed between first manifold **12** and second manifold **14** such that mini-channel tubes **18** of heat exchanger core **16** also extend in length between first manifold **12** and second manifold **14** and are fluidically connected to both first manifold **12** and second manifold **14**. As shown in FIG. **1**, first manifold **12** and second manifold **14** can be identical, symmetrical, or mirror symmetric to one another. Thus, the description of first manifold **12** can also describe second manifold **14**. The description below will primarily focus on first manifold **12**, though the description will apply to both first manifold **12** and second manifold **14**.

Base plate **30** of first manifold **12** can generally be rectangular, and side flanges **32** can be connected to at least two sides of base plate **30** and can extend obliquely from base plate **30**. Body **24** and fluid channel **28** of first manifold **12** can extend from base plate **30** opposite the bottom side of first manifold **12** and opposite air fine core **16**. Body **24**, fluid channel **28**, base sheet **30**, and side flanges **32** of first manifold **12** can all be formed as a single, integral, extruded piece, or as a single, integral, casted piece. Plate **26** can be a separate component from body **24** and can be brazed to body **24** of first manifold **12**.

Two end panels **20** can extend between first manifold **12** and second manifold **14** with heat exchanger core **16** being disposed between end panels **20**. Both end panels **20** are connected to side flanges **32** of first manifold **12** and side flanges **32** of second manifold **14**. End panels **20**, along with first manifold **12** and second manifold **14**, can form a supportive frame for heat exchanger assembly **10**. Two of fittings **22** are connected to fluid channel **28** of first manifold **12**, with one of fittings **22** connected to each end of fluid channel **28** of first manifold **12**. Two fittings **22** are also connected to fluid channel **28** of second manifold **14**, with one of fittings **22** connected to each end of fluid channel **28** of second manifold **14**. During operation, pressurized fluid can enter heat exchanger assembly **10** through fittings **22** connected to fluid channel **28** of first manifold **12**. After traveling through mini-channel tubes **18** of heat exchanger core **16**, the pressurized fluid can exit heat exchanger assembly **10** through fittings **22** connected to fluid channel **28** of second manifold **12**.

First manifold **12** and second manifold **14** can be formed from aluminum alloy 6063, or any other metal or material that possess the necessary strength and thermal properties to withstand the operating pressures and temperatures of heat exchanger assembly **10**. Mini-channel tubes **18** of heat exchanger core **16** can be formed from aluminum alloy 31104, or any other metal or material that possess the necessary strength to withstand the operating pressures of heat exchanger assembly **10** and the necessary thermal conductivity to meet the heat transfer requirements of heat exchanger assembly **10**. Air fins connected to mini-channel tubes **18** can be formed from aluminum alloy 6951 or any other metal or material that possess the necessary thermal conductivity to meet the heat transfer requirements of heat exchanger assembly **10**. First manifold **12** and second manifold **14** are discussed in greater below with reference to FIGS. **2A-5**.

FIGS. **2A-5** will be discussed concurrently. FIG. **2A** is a perspective view of first manifold **12** from heat exchanger assembly **10** of FIG. **1**. FIG. **2B** is an enlarged perspective view of first manifold **12** from FIG. **2A**, and FIG. **3** is an enlarged perspective view of first manifold **12** from FIG. **2A** with plate **26** removed. FIG. **4** is a cross-sectional view of first manifold **12** of FIG. **3** taken along line A-A and also showing mini-channel tubes **18** connected to first manifold **12**. FIG. **5** is an end elevation view of heat exchanger assembly **10** from FIG. **1**. As previously discussed with reference to FIG. **1**, first manifold **12** and second manifold **14** can be identical, thus, while the description below will be primarily directed to first manifold **12**, the description of first manifold **12** can also be equally applied to describe second manifold **14**.

As shown in FIGS. **2A-5**, body **24** of first manifold **12** can include first end **34**, second end **36**, top surface **38**, bottom surface **40**, first side surface **42**, second side surface **44**, a first plurality of chambers **46**, a second plurality of chambers **48**, partitions **50**, and grooves **52**. Each chamber **46** of the first plurality of chambers **46** can include first opening **54**, second opening **56**, angle A_1, and top opening **58**. Each chamber **48** of the second plurality of chambers **48** can include first opening **60**, second opening **62**, angle A_2, and top opening **64**. Plate **26** of first manifold **12** can include slots **66**. Fluid channel **28** of first manifold **12** can include first end **68**, second end **70**, bottom surface **72**, and a plurality of openings **74**.

First end **34** of body **24** is disposed opposite second end **36** of body **24**. Top surface **38** of body **24** can extend from first end **34** to second end **36** of body **24** and is disposed opposite bottom surface **40** of body **24**. Top surface **38** can be parallel to bottom surface **40**. As shown in FIGS. **2A-5**, bottom surface **40** of body **24** can be continuous with a bottom surface of base plate **30** of first manifold **12**. First side surface **42** of body **24** extends between top surface **38** and bottom surface **40** of body **24**, and can also extend from first end **34** to second end **36** of body **24**. Second side surface **44** extends between top surface **38** and bottom surface **40** of body **24** opposite first side surface **42**, and can also extend from first end **34** to second end **36** of body **24**. As shown in FIGS. **2A-5**, bottom surface **40** of body **24** can be larger in width than top surface **38** and centered under top surface **38** such that top surface **38**, bottom surface **40**, first side surface **42**, and second side surface **44** cause body **24** to have an extruded trapezoid-shaped profile.

As shown best in FIG. **2B**, first ridge **41** can be formed on top surface **38** where first side surface **42** meets top surface **38**. First ridge **41** can also extend from first end **34** to second end **36** of body **24**. Second ridge **43** can be formed on top surface **38** where second side surface **44** meets top surface **38**. Similar to first ridge **41**, second ridge **43** can extend from first end **34** to second end **36** of body **24**. Plate **26** is disposed on top surface **38** of body **24** between first ridge **41** and second ridge **43** and can extend from first end **34** to second end **36** of body **24**. During the assembling of first manifold **12**, first ridge **41** and second ridge **43** can aid in positioning plate **26** on top surface **38** of body **24** as plate **26** is attached to body **24**, such as by brazing or welding.

Before plate **26** is brazed to body **24**, the first plurality of chambers **46** and the second plurality of chambers **48** can both be formed in body **24**. As shown best in FIGS. **3-4**, the first plurality of chambers **46** is formed in body **24** such that each chamber **46** of the first plurality of chambers **46** extends from top surface **38** to bottom surface **40** of body **24**. Each chamber **46** of the first plurality of chambers **46** also extends between first side surface **42** and an intermediate plane disposed between first side surface **42** and second side surface **44**. As shown in FIG. **3**, each chamber **46** of the first plurality of chambers **46** is spaced apart from one another between first end **34** and second end **36** of body **24** such that chambers **46** are aligned in a single row that extends between first end **34** and second end **36**.

The second plurality of chambers **48** are also formed in body **24**. Each chamber **48** of the second plurality of chambers **48** extends from top surface **38** of body **24** to bottom surface **40** of body **24**. Each chamber **48** of the second plurality of chambers **48** also extends between second side surface **44** and the intermediate plane disposed between first side surface **42** and second side surface **44**. As shown in FIG. **3**, the intermediate plane can also be described as a reference plane disposed between the second plurality of chambers **48** and the first plurality of chambers **46**. Similar in fashion as the first plurality of chambers **46**, each chamber **48** of the second plurality of chambers **48** is spaced apart from one another between first end **34** and second end **36** of body **24** such that chambers **48** are aligned in a second single row that extends between first end **34** and second end **36**.

Each chamber **46** of the first plurality of chambers **46** can be aligned with one of the second plurality of chambers **48** between first side surface **42** and second side surface **44**. Partitions **50** can be formed on the intermediate plane between the first plurality of chambers **46** and the second plurality of chambers **48** and can physically separate and fluidically isolate the first plurality of chambers **46** from the second plurality of chambers **48** in first manifold **12**. Grooves **52** can be formed in top surface **38** of body **24** such that each groove **52** extends from first side surface **42** to second side surface **44** and intersects top surface **38**, first side surface **42**, second side surface **44**, first ridge **41**, and second ridge **43**. As shown best in FIG. **3**, each one of grooves **52** can be disposed between two chambers **46** of the first plurality of chambers **46** and two chambers **48** of the second plurality of chambers **48**. While grooves **52** are disposed between individual chambers **46** and chambers **48**, grooves **52** do not intersect any of the chambers of the first plurality of chambers **46** or the second plurality of chambers **48**. Grooves **52** reduce the overall weight of first manifold **12** by eliminating excess material disposed between each of chambers **46** of the first plurality of chambers **46** and the excess material disposed between each of chambers **48** of the second plurality of chambers **48**.

Slots **66** can be formed in plate **26** such that each of slots **66** is positioned over one of grooves **52** and between chambers **46** of the first plurality of chambers and between chambers **48** of the second plurality of chambers **48**. Slots **66** of plate **26** are not positioned over any chambers **46** of the first plurality of chambers **46** nor any chambers **48** of the second plurality of chambers **48**. Similar to grooves **52**, slots **66** reduce the overall weight of first manifold **12** by eliminating unnecessary material from plate **26**.

FIGS. **4** and **5** best show the internal geometry of each chamber **46** of the first plurality of chambers **46** and the internal geometry of each chamber **48** of the second plurality of chambers **48**. The first plurality of chambers **46** and the second plurality of chambers **48** are shown in phantom in FIG. **5**. As shown in FIGS. **4** and **5**, each chamber **46** of the first plurality of chambers **46** can include first opening **54**, second opening **56**, and top opening **58**. First opening **54** of chamber **46** of the first plurality of chambers **46** can extend through bottom surface **40** of body **24** proximate where first side surface **42** meets bottom surface **40** of body **24**. Second opening **56** of chamber **46** of the first plurality of chambers **46** can extend through bottom surface **40** of body **24** between the position of first opening **54** and partition **50**.

Both first opening **54** and second opening **56** of chamber **46** of the first plurality of chambers **46** are sized and configured to each receive one end of one of mini-channel tubes **18** of heat exchanger core **16**. Because first opening **54** and second opening **56** of chamber **46** of the first plurality of chambers are each configured to be connected to just one of mini-channel tubes **18**, chamber **46** of the first plurality of chambers **46** is connected to no more than two of mini-channel tubes **18**. As shown in FIG. **4**, chamber **46** of the first plurality of chambers **46**, along with first opening **54** and second opening **56**, can be approximately equal in width as one of mini-channel tubes **18**, width being defined as the dimension that extends parallel to the direction extending between first end **34** and second end **36** of body **24**.

Top opening **58** of chamber **46** of the first plurality of chambers **46** can extend through top surface **38** of body **24** between first ridge **41** and partition **50**. Top opening **58** of chamber **46** of the first plurality of chambers **46** can be formed as a byproduct of forming chamber **46** in body **24** by subtractive manufacturing, such as by machining. To aid in the manufacturing of the first plurality of chambers **46**, first side surface **42** can extend from bottom surface **40** toward top surface **38** at angle A_1. Angle A_1 can be selected from the range of approximately 30 degrees to approximately 45 degrees. By selecting angle A_1 from the range of approximately 30 degrees to approximately 45 degrees, angle A_1 provides enough space between bottom surface **40**, first side surface **42**, and top surface **38** to allow machining tools, such as a rotary cutter, to adequately access the interior of body **24** to form each chamber **46** of the first plurality of chambers **46**. Additionally, this angle range is optimal to best distribute the flow of fluid F from mini-channel tubes **18** through chamber **46** back into mini-channel tubes **18**.

As shown in FIGS. **4** and **5**, the internal geometry of second chamber **48** of the second plurality of chambers **48** can be mirror symmetric with the internal geometry of chamber **46** of the first plurality of chambers **46**. Each chamber **48** of the second plurality of chambers **48** can include first opening **60**, second opening **62**, and top opening **64**. First opening **60** of chamber **48** of the second plurality of chambers **48** can extend through bottom surface **40** of body **24** proximate where partition **50** meets bottom surface **40** of body **24**. Second opening **62** of chamber **48** of the second plurality of chambers **48** can extend through bottom surface **40** of body **24** between the position of first opening **62** of chamber **48** of the second plurality of chambers **48** and partition **50**.

Both first opening **60** and second opening **62** of chamber **48** of the second plurality of chambers **48** are sized and configured to each receive one end of one of mini-channel tubes **18** of heat exchanger core **16**. Because first opening **60** and second opening **62** of chamber **48** of the second plurality of chambers are each configured to be connected to just one of mini-channel tubes **18**, chamber **48** of the second plurality of chambers **48** is connected to no more than two of mini-channel tubes **48**. As shown in FIG. **4**, chamber **48** of the second plurality of chambers **48**, along with first opening **60** and second opening **62** of chamber **48**, can be approximately equal in width as one of mini-channel tubes **18**, width being defined as the dimension that extends parallel to the direction extending between first end **34** and second end **36** of body **24**.

Top opening **64** of chamber **48** of the second plurality of chambers **48** can extend through top surface **38** of body **24** between partition **50** and second ridge **43**. Top opening **64** of chamber **48** of the second plurality of chambers **48** can be formed as a byproduct of forming chamber **48** in body **24** by subtractive manufacturing, such as by machining. To aid in the manufacturing of the second plurality of chambers **48**, second side surface **44** can extend from bottom surface **40** toward top surface **38** at angle A_2. Angle A_2 can be selected from the range of approximately 30 degrees to approximately 45 degrees. By selecting angle A_2 from the range of approximately 30 degrees to approximately 45 degrees, angle A_2 provides enough space between bottom surface **40**, second side surface **44**, and top surface **38** to allow machining tools, such as a rotary cutter, to adequately access the interior of body **24** to form each chamber **48** of the second plurality of chambers **48**. This angle range is optimal to best distribute the flow of fluid F from mini-channel tubes **18** through chamber **46** back into mini-channel tubes **18**. Angel A_1 can be equal to angle A_2.

Once the first plurality of chambers **46** and the second plurality of chambers **48** are formed, plate **26** can be connected by brazing to top surface **38** of body **24** to cover and close each top opening **58** of the first plurality of chambers **46** and to cover and close each top opening **64** of the second plurality of chambers **48**. Plate **26** can be a flat plate, or plate **26** can be curved so as to aid in counteracting any pressure stress that plate **26** my experience during operation of heat exchanger assembly **10**.

Fluid channel **28** of first manifold **12** can extend generally parallel to body **24** with first end **68** of fluid channel **28** being disposed opposite second end **70** of fluid channel **28** (shown in FIG. 2A). As shown in FIG. **5**, fluid channel bottom surface **72** can be continuous with the bottom surface of base plate **30** and bottom surface **40** of body **24**. The plurality of openings **74** can be formed in fluid channel bottom surface **72**. Each opening **74** of the plurality of openings **74** of fluid channel **28** can be configured to receive no more than one of mini-channel tubes **18**, as shown in FIG. **5**.

During operation of heat exchanger assembly **10** (shown in FIGS. **4** and **5**), high pressure fluid F (which can be a gas or liquid) enters fluid channel **28** of first manifold **12**. After entering fluid channel **28**, fluid F is divided as fluid F flows through the plurality of openings **74** formed in fluid channel bottom surface **72**. Fluid F then enters a row of mini-channel tubes **18** that are connected between fluid channel **28** of first manifold **12** and the second plurality of chambers **48** of second manifold **14**. Because each of mini-channel tubes **18** connected to fluid channel **28** of first manifold **12** is connected to only one chamber **48** of the second plurality of chambers **48** of the second manifold **14**, fluid F remains divided into separate streams as fluid F travels from fluid channel **28** across mini-channel tubes **18** and enters the second plurality of chambers **48** of second manifold **14**. The separate streams of fluid F then travel respectively from the second plurality of chambers **48** of second manifold **14** into mini-channel tubes **18** connected between the second plurality of chambers **48** of second manifold **14** and the first plurality of chambers **46** of first manifold **12**.

After the separate streams of fluid F enter the first plurality of chambers **46** of the first manifold **12** respectively, the separate streams of fluid F then travel respectively from the first plurality of chambers **46** of first manifold **12** into mini-channel tubes **18** connected between the first plurality of chambers **46** of first manifold **12** and the first plurality of chambers **46** of second manifold **14**. Once the separate streams of fluid F enter the first plurality of chambers **46** of second manifold **14** respectively, the separate streams of fluid F then travel respectively from the first plurality of chambers **46** of second manifold **14** into mini-channel tubes **18** connected between the first plurality of chambers **46** of second manifold **14** and the second plurality of chambers **48** of first manifold **12**.

After flowing across the second plurality of chambers **48** of first manifold **12**, the separate streams of fluid F can then travel through a final row of mini-channel tubes **18** connected between the second plurality of chambers **48** of first manifold **12** and fluid channel **28** of second manifold **14**. Once the separate streams of fluid F have traveled through the final row of mini-channel tubes **18**, the separate streams of fluid F pass through the plurality of openings **74** of fluid channel **28** of second manifold **14** and enter the fluid channel **28** of second manifold **14**. Inside fluid channel **28** of second manifold **14**, the separate streams of fluid F join together again into a single flow stream before exiting fluid channel **28** of second manifold **14** and heat exchange assembly **10**.

Because fluid F travels across first manifold **12** and second manifold **14** in separate streams in chambers **46** and **48** that are sized according to the size of mini-channel tubes **18**, the amount of fluid F needed to fill first manifold **12**, second manifold **14**, and mini-channel tubes **18** is less than a conventional heat exchanger where the streams of fluid are rejoined in a larger common chamber every instance the fluid passes from the mini-channel tubes into a conventional manifold or header. By reducing the amount of fluid F needed to fill heat exchanger assembly **10**, first manifold **12** and second manifold **14** reduce the overall operational weight of heat exchanger assembly **10** without changing the size of heat exchanger assembly **10**. In applications such as aerospace of automotive vehicles, reducing the weight of a heat exchanger assembly will translate into overall weight reduction of a vehicle or aircraft and increased fuel economy.

In view of the foregoing description, it will be recognized that the present disclosure provides numerous advantages and benefits. For example, the present disclosure provides heat exchanger assembly **10** that requires less fluid volume than conventional heat exchanger assemblies of comparable size. First manifold **12** and second manifold **14** of heat exchanger assembly **10** also require less brazing during manufacturing than conventional heat exchanger assemblies because first manifold **12** and second manifold **14** each comprise only two components.

The following are non-exclusive descriptions of possible embodiments of the present invention.

In one embodiment, a manifold for a heat exchanger assembly includes a body and a plate. The body includes a first end disposed opposite a second end, and a top surface disposed opposite a bottom surface. The body also includes a first side surface extending between the top surface and the bottom surface, and a second side surface extending between the top surface and the bottom surface opposite the first side surface. A first plurality of chambers are formed in the body such that each chamber of the first plurality of chambers extends from the top surface to the bottom surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface. Each chamber of the first plurality of chambers is also spaced apart from one another between the first end and the second end of the body. A second plurality of chambers is also formed in the body. Each chamber of the second plurality of chambers extends from the top surface to the bottom surface and extends between the second side surface and the intermediate plane. Each chamber of the second plurality of chambers is also spaced apart from one another between the first end and the second end of the body. The plate is disposed on the top surface of the body.

The manifold of the preceding paragraph can optionally include, additionally and/or alternatively, any one or more of the following features, configurations and/or additional components:

the top surface is parallel to the bottom surface, and the first side surface extends from the bottom surface toward the top surface at an angle selected from the range of approximately 30 degrees to approximately 45 degrees;

the second side surface extends from the bottom surface toward the top surface at an angle selected from the range of approximately 30 degrees to approximately 45 degrees;

each chamber of the first plurality of chambers comprises: a first opening extending through the bottom surface; and a second opening extending through the bottom surface, wherein the first opening of each chamber of the first plurality of chambers is configured to receive a mini-channel tube, and wherein the second opening of each chamber of the first plurality of chambers is configured to receive a mini-channel tube;

each chamber of the second plurality of chambers comprises: a first opening extending through the bottom surface; and a second opening extending through the bottom surface, wherein the first opening of each chamber of the second plurality of chambers is configured to receive a mini-channel tube, and wherein the second opening of each chamber of the second plurality of chambers is configured to receive a mini-channel tube;

each chamber of the first plurality of chambers is aligned with a chamber of the second plurality of chambers between the first side surface and the second side surface;

the body of the manifold further comprises: a plurality of grooves formed in the top surface of the body such that each groove extends from the first side surface to the second side surface, wherein each groove of the plurality of grooves is disposed between two chambers of the first plurality of chambers and two chambers of the second plurality of chambers;

the plate comprises: a plurality of slots formed in the plate, wherein each slot of the plurality of slots is positioned over one groove of the plurality of grooves; and/or

a heat exchanger assembly comprising the manifold, wherein the heat exchanger assembly comprises: a second manifold of similar configuration to the manifold disposed opposite the manifold such that the bottom surface of the manifold faces a bottom surface of the second manifold; and a plurality of mini-channel tubes extending between the manifold and the second manifold, wherein each chamber of the first plurality of chambers of the manifold is connected to no more than two mini-channel tubes of the plurality of mini-channel tubes, and wherein each chamber of the second plurality of chambers of the manifold is connected to no more than two mini-channel tubes of the plurality of mini-channel tubes.

In another embodiment, a manifold for a heat exchanger assembly includes a body having a first end disposed opposite a second end and a top surface disposed opposite a bottom surface. The body further includes a first side surface extending between the top surface and the bottom surface and a second side surface extending between the top surface and the bottom surface opposite the first side surface. A first plurality of chambers is formed in the body such that each chamber of the first plurality of chambers extends from the bottom surface towards the top surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface. Each chamber of the first plurality of chambers is also spaced apart from one another between the first end and the second end of the body. A second plurality of chambers is also formed in the body. Each chamber of the second plurality of chambers extends from the bottom surface towards the top surface and extends between the second side surface and the intermediate plane. Each chamber of the second plurality of chambers is also spaced apart from one another between the first end and the second end of the body.

The manifold of the preceding paragraph can optionally include, additionally and/or alternatively, any one or more of the following features, configurations and/or additional components:

each chamber of the first plurality of chambers and each chamber of the second plurality of chambers extends through both the top surface and the bottom surface of the body;

the manifold further comprises: a plate disposed on the top surface of the body;

each chamber of the first plurality of chambers is configured to be connected to no more than two mini-channel tubes proximate the bottom surface, and each chamber of the second plurality of chambers is configured to be connected to no more than two mini-channel tubes proximate the bottom surface;

a fluid channel extending generally parallel to the body, wherein the fluid channel comprises: a first end disposed opposite a second end; a fluid channel bottom surface; and a plurality of openings formed in the fluid channel bottom surface, wherein each opening of the plurality of openings is configured to receive no more than one mini-channel tube; and/or

the manifold further comprises: a first fitting connected to the first end of the fluid channel; and a second fitting connected to the second end of the fluid channel.

Any relative terms or terms of degree used herein, such as "substantially", "essentially", "generally", "approximately", and the like, should be interpreted in accordance with and subject to any applicable definitions or limits expressly stated herein. In all instances, any relative terms or terms of degree used herein should be interpreted to broadly encompass any relevant disclosed embodiments as well as such ranges or variations as would be understood by a person of ordinary skill in the art in view of the entirety of the present disclosure, such as to encompass ordinary manufacturing tolerance variations, incidental alignment variations, transitory vibrations and sway movements, temporary alignment or shape variations induced by operational conditions, and the like.

While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. For example, while FIGS. **1-5** show first manifold **12** and second manifold **14** each comprising plate **26** to cover top openings **58** and **64** of the first plurality of chambers **46** and the second plurality of chambers **48** respectively, first manifold **12** and second manifold **14** can each be manufactured through additive manufacturing or any other process such that the first plurality of openings **46** and the second plurality of openings **48** extend from bottom surface **40** of body **24** toward top surface **38** of body **24** without extending through top surface **38**. By thus manufacturing first manifold **12** and second manifold **14**, plate **26** can be eliminated from first manifold **12** and second manifold **14** without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

The invention claimed is:

1. A manifold for a heat exchanger assembly, the manifold comprising:

a body comprising:

a first end disposed opposite a second end;

a top surface disposed opposite a bottom surface;

a first side surface extending between the top surface and the bottom surface;

a second side surface extending between the top surface and the bottom surface opposite the first side surface;

a first plurality of chambers formed in the body, wherein each chamber of the first plurality of chambers extends from the top surface to the bottom surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface, and wherein each chamber of the first plurality of chambers is spaced apart from one another between the first end and the second end of the body; and

a second plurality of chambers formed in the body, wherein each chamber of the second plurality of chambers extends from the top surface to the bottom surface and extends between the second side surface and the intermediate plane, and wherein each chamber of the second plurality of chambers is spaced apart from one another between the first end and the second end of the body,

wherein the top surface is parallel to the bottom surface, and the first side surface extends from the bottom surface toward the top surface at an angle selected from the range of approximately 30 degrees to approximately 45 degrees; and

a plate disposed on the top surface of the body.

2. The manifold of claim **1**, wherein the second side surface extends from the bottom surface toward the top surface at an angle selected from the range of approximately 30 degrees to approximately 45 degrees.

3. The manifold of claim **1**, wherein each chamber of the first plurality of chambers comprises:

a first opening extending through the bottom surface; and

a second opening extending through the bottom surface,

wherein the first opening of each chamber of the first plurality of chambers is configured to receive a mini-channel tube, and

wherein the second opening of each chamber of the first plurality of chambers is configured to receive a mini-channel tube.

4. The manifold of claim **3**, wherein each chamber of the second plurality of chambers comprises:

a first opening extending through the bottom surface; and

a second opening extending through the bottom surface,

wherein the first opening of each chamber of the second plurality of chambers is configured to receive a mini-channel tube, and

wherein the second opening of each chamber of the second plurality of chambers is configured to receive a mini-channel tube.

5. The manifold of claim **4**, wherein each chamber of the first plurality of chambers is aligned with a chamber of the second plurality of chambers between the first side surface and the second side surface.

6. The manifold of claim **5**, wherein the body of the manifold further comprises:

a plurality of grooves formed in the top surface of the body such that each groove extends from the first side surface to the second side surface,

wherein each groove of the plurality of grooves is disposed between two chambers of the first plurality of chambers and two chambers of the second plurality of chambers.

7. The manifold of claim **6**, wherein the plate comprises:

a plurality of slots formed in the plate,

wherein each slot of the plurality of slots is positioned over one groove of the plurality of grooves.

8. A heat exchanger assembly comprising the manifold of claim **1**, wherein the heat exchanger assembly comprises:

a second manifold disposed opposite the manifold such that the bottom surface of the manifold faces a bottom surface of the second manifold; and

a plurality of mini-channel tubes extending between the manifold and the second manifold,

wherein each chamber of the first plurality of chambers of the manifold is connected to no more than two mini-channel tubes of the plurality of mini-channel tubes, and

wherein each chamber of the second plurality of chambers of the manifold is connected to no more than two mini-channel tubes of the plurality of mini-channel tubes.

9. A manifold for a heat exchanger assembly, the manifold comprising:

a body comprising:

a first end disposed opposite a second end;

a top surface disposed opposite a bottom surface;

a first side surface extending between the top surface and the bottom surface;

a second side surface extending between the top surface and the bottom surface opposite the first side surface;

a first plurality of chambers formed in the body, wherein each chamber of the first plurality of chambers extends from the bottom surface towards the top surface and extends between the first side surface and an intermediate plane disposed between the first side surface and the second side surface, and wherein each chamber of the first plurality of chambers is spaced apart from one another between the first end and the second end of the body; and

a second plurality of chambers formed in the body, wherein each chamber of the second plurality of chambers extends from the bottom surface towards the top surface and extends between the second side surface and the intermediate plane, and wherein each chamber of the second plurality of chambers is spaced apart from one another between the first end and the second end of the body,

wherein the top surface is parallel to the bottom surface, and the first side surface extends from the bottom surface toward the top surface at an angle selected from the range of approximately 30 degrees to approximately 45 degrees.

10. The manifold of claim **9**, wherein each chamber of the first plurality of chambers and each chamber of the second plurality of chambers extends through both the top surface and the bottom surface of the body.

11. The manifold of claim **10**, wherein the manifold further comprises:

a plate disposed on the top surface of the body.

12. The manifold of claim **11**, wherein each chamber of the first plurality of chambers is configured to be connected to no more than two mini-channel tubes proximate the bottom surface, and each chamber of the second plurality of chambers is configured to be connected to no more than two mini-channel tubes proximate the bottom surface.

13. The manifold of claim **12**, wherein the manifold further comprises:

a fluid channel extending generally parallel to the body, wherein the fluid channel comprises:

a first end disposed opposite a second end;

a fluid channel bottom surface; and

a plurality of openings formed in the fluid channel bottom surface, wherein each opening of the plurality of openings is configured to receive no more than one mini-channel tube.

14. The manifold of claim **13**, wherein the manifold further comprises:

a first fitting connected to the first end of the fluid channel; and

a second fitting connected to the second end of the fluid channel.

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